

DEPARTMENT OF THE ARMY
EUROPE DIVISION, CORPS OF ENGINEERS

APD 09757

ENERGY ENGINEERING ANALYSIS PROGRAM

54TH AREA SUPPORT GROUP

RHEINBERG, FRG

EXECUTIVE SUMMARY

1 MAY 1984

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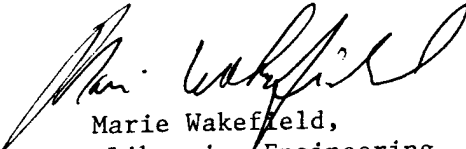


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ENERGY ENGINEERING ANALYSIS PROGRAM (EEAP)
GLOSSARY OF TERMS AND ABBREVIATIONS
ENERGY REPORT

AAFES	-	ARMY AIR FORCE EXCHANGE SERVICE
ADMIN	-	ADMINISTRATION
AFCENT	-	ALLIED FORCES CENTRAL
AHU	-	AIR HANDLING UNIT
ASG	-	AREA SUPPORT GROUP
ASHRAE	-	AMERICAN SOCIETY OF HEATING, REFRIGERATION, AND AIR CONDITIONING ENGINEERS, INC.
AVG	-	AVERAGE
BAR	-	BAR: 14.5 PSI
BE	-	BELGIUM
BEQ	-	BACHELOR ENLISTED QUARTERS
BF	-	BELGIUM FRANC
BKS	-	BARRACKS
BLDG	-	BUILDING
BOQ	-	BACHELOR OFFICER'S QUARTERS
BTU	-	BRITISH THERMAL UNIT: A HEAT UNIT EQUAL TO THE AMOUNT OF HEAT REQUIRED TO RAISE ONE POUND OF WATER ONE DEGREE FAHRENHEIT.
BTU/HR OR BTUH	-	BRITISH THERMAL UNITS PER HOUR
C	-	CELSIUS
C & D	-	CHIEVRES & DAUMERIE
CFH	-	CUBIC FEET PER HOUR
CFM	-	CUBIC FEET PER MINUTE
CMU	-	CONCRETE MASONRY UNIT (BLOCK)
COMM	-	COMMISSARY

Glossary of Terms and Abbreviations (continued)

COMTY	-	COMMUNITY
CUFT	-	CUBIC FOOT
DA	-	DEPARTMENT OF THE ARMY
DD	-	DEGREE DAY: THE DIFFERENCE BETWEEN THE AVERAGE TEMPERATURE FOR A DAY AND 65° F.
DEH	-	DIRECTOR OF ENGINEERING AND HOUSING
DG	-	DUTCH GUILDER
DHW	-	DOMESTIC HOT WATER
DM	-	DEUTSCHE MARK
DOE	-	DEPARTMENT OF ENERGY
ECIP	-	ENERGY CONSERVATION INVESTMENT PROGRAM
ECO	-	ENERGY CONSERVATION OPPORTUNITY
ECOS	-	ENERGY CONSERVATION OPPORTUNITIES
EEAP	-	ENERGY ENGINEERING ANALYSIS PROGRAM
EFF	-	EFFICIENCY
EMCS	-	ENERGY MONITORING AND CONTROL SYSTEM
ESIR	-	ENERGY SAVINGS-TO-INVESTMENT RATIO
ESP	-	ENERGY SIMULATION PROGRAM
EUD	-	EUROPE DIVISION, CORPS OF ENGINEERS
F	-	FAHRENHEIT
FG	-	FIBERGLASS
FH	-	FAMILY HOUSING
FLUO	-	FLUORESCENT
FO	-	FUEL OIL
FRG	-	FEDERAL REPUBLIC OF GERMANY (WEST GERMANY)
FT	-	FEET
FUNC	-	FUNCTION
FY	-	FISCAL YEAR

Glossary of Terms and Abbreviations (continued)

GAL	-	GALLON
GPM	-	GALLONS PER MINUTE
GWB	-	GYPSUM WALL BOARD
GY AREA	-	GERMANY (GY) AREA
HGT	-	HEIGHT
HVAC	-	HEATING, VENTILATING, AIR CONDITIONING
KASER	-	KASERNE
KW	-	KILOWATT, 1000 WATTS
KWHR	-	KILOWATT HOUR
LAB	-	LABORATORY
LF	-	LINEAL FOOT
M	-	METER
M3	-	CUBIC METERS
MAN	-	MANUAL
MBTU	-	ONE MILLION BRITISH THERMAL UNITS
MEGA	-	MILLION
MH/MH	-	MAN-HOUR
MM	-	MILLIMETER
MO	-	MONTH
M & R	-	MAINTENANCE AND REPAIR
MUX	-	MULTIPLEX
MW	-	MEGAWATT, ONE MILLION WATTS
MWH	-	MEGAWATT-HOUR, ONE MILLION WATT-HOUR
MWHR	-	MEGAWATT-HOUR, ONE MILLION WATT-HOUR
MWHS	-	MEGAWATT-HOUR, ONE MILLION WATT-HOURS
NATO	-	NORTH ATLANTIC TREATY ORGANIZATION
N/A	-	NOT APPLICABLE; NOT AVAILABLE

Glossary of Terms and Abbreviations (continued)

NBS	-	NATIONAL BUREAU OF STANDARDS
NE	-	NETHERLANDS
NL	-	NETHERLANDS
NOAA	-	NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NO.	-	NUMBER
NSSG	-	NATO SHAPE SUPPORT GROUP
OA	-	OUTSIDE AIR
OCCUP	-	OCCUPANCY
OH	-	OVERHEAD
OPER	-	OPERATIONS
O & M	-	OPERATION AND MAINTENANCE
PF	-	POWER FACTOR; RELATIONSHIP BETWEEN KW AND KVA. WHEN THE POWER FACTOR IS UNITY, KVA EQUALS KW.
PF	-	PFENNING
POMCUS	-	PREPOSITIONED MATERIAL CONFIGURED TO UNIT SETS
PSI(A)(G)	-	POUNDS PER SQUARE INCH (ABSOLUTE)(GAUGE)
PX	-	POST EXCHANGE
R-VALUE	-	THE RESISTANCE TO HEAT FLOW EXPRESSED IN UNITS OF (SQUARE FEET)(HOUR)(DEGREE F.)/BTU; R VALUE - 1/U VALUE.
SA	-	SUPPORT ACTIVITY
SF	-	SQUARE FOOT
SHAPE	-	SUPREME HEADQUARTERS ALLIED POWERS EUROPE
SIR	-	SAVINGS-TO-INVESTMENT RATIO: TOTAL LIFE CYCLE BENEFITS DIVIDED BY 90 PERCENT OF THE DIFFERENTIAL INVESTMENT COST.
SIOH	-	SUPERVISION, INSPECTION AND OVERHEAD
SOS	-	STATEMENT OF SERVICES
SP	-	SINGLE PANE
STY	-	STORY
TRY	-	TEST REFERENCE YEAR

Glossary of Terms and Abbreviations (continued)

'U' VALUE	-	A COEFFICIENT EXPRESSING THE THERMAL CONDUCTANCE OF A COMPOSITE STRUCTURE IN BTU PER (SQUARE FOOT) (HOUR) (DEGREE F. TEMPERATURE DIFFERENCE)
UA	-	OVERALL HEAT TRANSFER COEFFICIENT (BTU/HR DEGREE F.)
UPW	-	UNIFORM PRESENT WORTH FACTOR: A FACTOR, WHICH WHEN APPLIED TO ANNUAL SAVINGS, WILL ACCOUNT FOR THE TIME VALUE OF MONEY AND INFLATION OVER THE LIFE OF THE PROJECT.
US	-	UNITED STATES
USAREUR	-	UNITED STATES ARMY; EUROPE
V	-	VOLT
VET	-	VETERINARY
W	-	WATT
WDW	-	WINDOW
WHSE	-	WAREHOUSE
WK	-	WEEK
YR/yr	-	YEAR

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1. INTRODUCTION

1.1. Scope.

This Summary outlines the information compiled during Phase II of Contract DACA 90-83-C-0013, "Energy Engineering Analysis Program."

The purpose of the contract is to reduce energy consumption in the community by identifying actions and/or projects that will accomplish this end. The contract is divided into three (3) phases:

1.1.1. Phase I - Data Gathering.

During this phase, data was compiled describing the pertinent features of energy consuming facilities and past history of energy consumption. This data is contained in the "Data Report" dated 15 April 1983.

1.1.2. Phase II - Data Analysis.

During this phase, the data collected in Phase I was analyzed. Energy conservation opportunities (ECOS) were identified and economically analyzed. The "Energy Report" presents recommendations, justifications, and preliminary DD Form 1391s.

1.1.3. Phase III - Project Documents.

During this phase, applicable DA Form 4283s, DD Form 1391s, and Project Development Brochures were prepared.

1.2. General Description.

The 54th Area Support Group has only recently begun leasing major portions of the Reichel Complex in Rheinberg, FRG. This facility is the former headquarters of the Reichel Corporation, a carpet manufacturer, which recently went into the equivalent of bankruptcy. The complex consists of:

- Ten-story office tower constructed of precast concrete, approximately 40 percent glazed and having an area of 312,000 square feet.
- Approximately one million square feet of warehouse/manufacturing space. The majority of this space is constructed of concrete with a barrel vault sawtooth roof having a large north facing skylight. One section is of all metal construction.
- Central Boiler Plant Building.

The facility, as of February 1983, is still managed by Reichel (or former Reichel) employees. A portion of the manufacturing area is still in operation under the control of a second carpet maker. The remainder of the manufacturing/warehouse space and part of the office building are unoccupied. This complex was selected to be surveyed because of the possibility that the U.S. Army acquire the property and develop the entire facility.

1.2.1. Location.

The 54th ASG is located on the southwest edge of the town of Rheinberg, West Germany. Rheinberg is located in far west central Germany near the City of Wesel.

1.2.2. Climate.

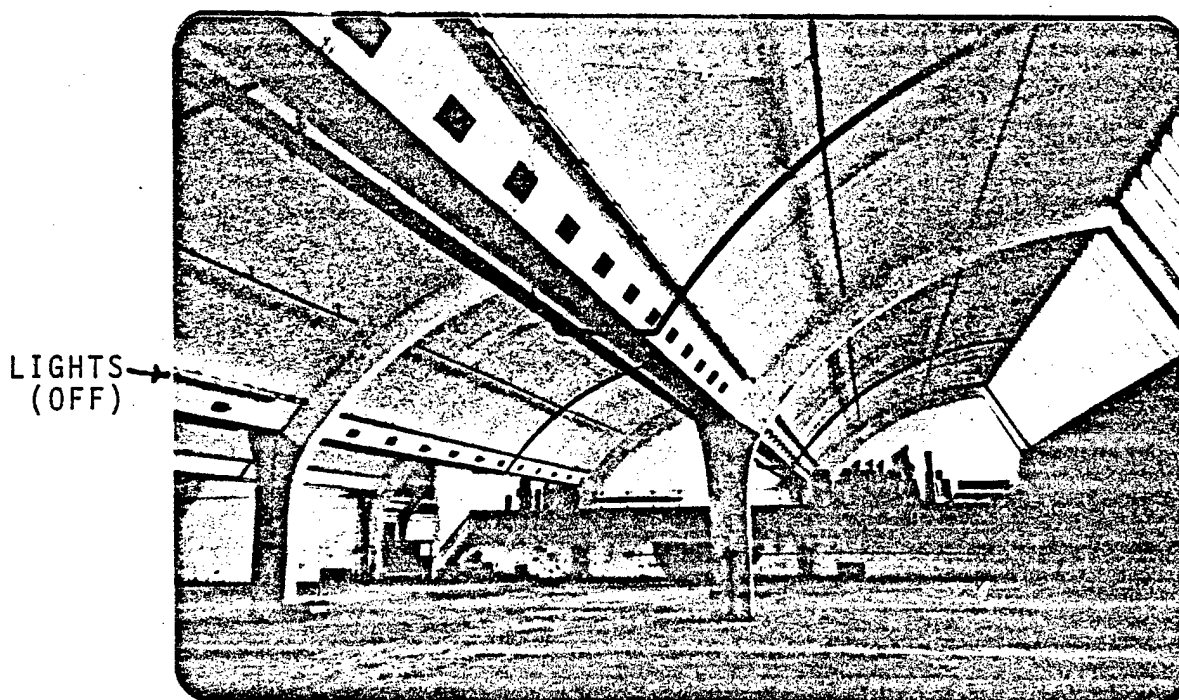
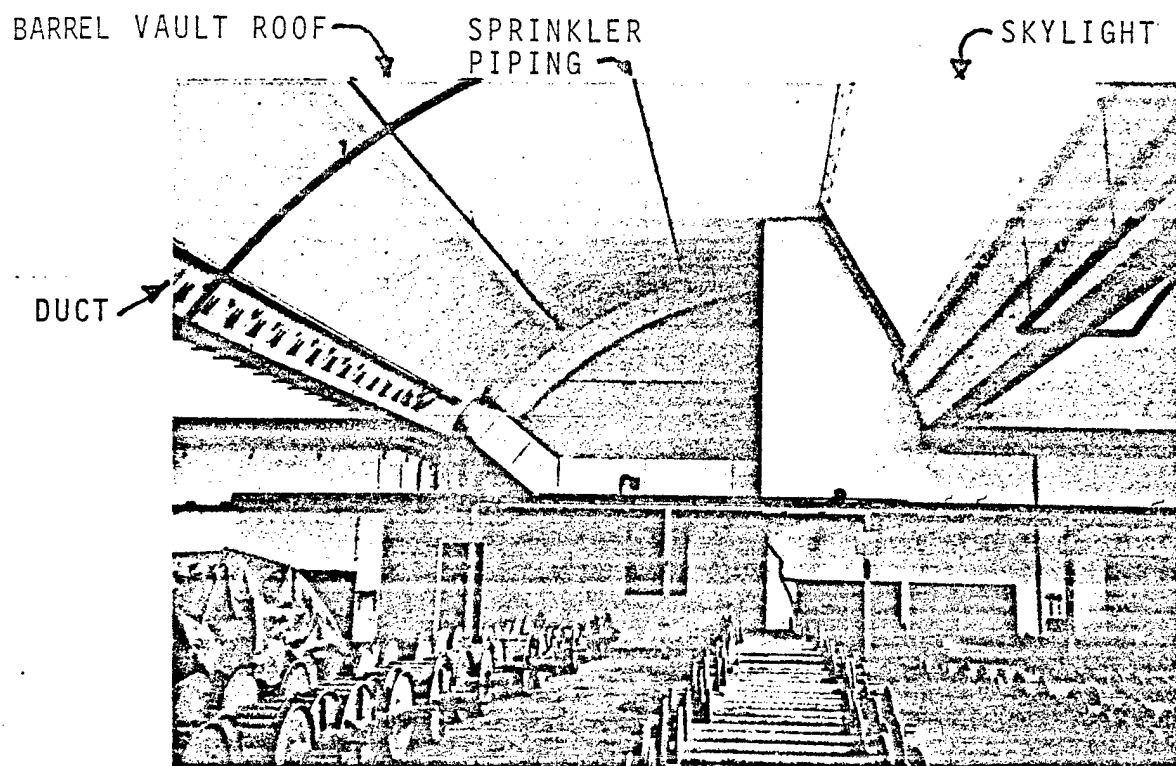
Rheinberg is at the eastern edge of the lowlands on the west side of the Rhein River. Its climate is moderate, typical of the inland cities of the low countries. Summers are cool and winters are mild. Skies are generally overcast with frequent light precipitation. While the average winter temperature is approximately 40° F., spring and fall temperatures are also cool resulting in a relatively high number of annual degree-days. There is no available weather station for Rheinberg. There are no weather stations listed in TM 5-785 in the immediate vicinity.

Rheinberg is assumed to have approximately the same weather conditions as Chievres, Belgium which is tabulated in TM.5-785.

1.2.3. Facilities.

This facility was built in several stages, there are, therefore, several different types of construction. With the exception of a few minor out buildings, this is one interconnected building. The overall plan, with the present "Building Numbers" is shown in Figure 1.1. There are three (3) major construction categories:

- Building 22 is a 10-story office tower with penthouse boardroom. It is constructed of precast concrete and approximately 40 percent glazed. The short dimension is only 65 feet so that with careful layout, cross ventilation can be maintained and no air conditioning is required (or installed). The building is heated with hot water radiators. The southwest facing glass is equipped with external shutters which, when closed, are operable similar to venetian blinds.
- Buildings 7, 8, and 12 through 20 are single story concrete with a barrel vault sawtooth roof, each bay of which has a large north facing skylight. These are manufacturing/storage spaces. The skylights are double-glazed and provide enough ambient lighting for general use without artificial illumination. Even in the presently active manufacturing space, artificial lighting was only installed on the machinery as task lighting. (See Figure 1-2).



TYPICAL WAREHOUSE CONSTRUCTION

Figure 1-2.

- Buildings 5, 6, 9, 10, 11, and 21 are similar to the other manufacturing spaces except are two-story high. The ground floor of these spaces, having glazing only in the exterior walls, lacks the natural lighting of the other factory spaces. These were used for storage or are vacant.

1.2.4. Occupancy.

At the time of the survey in February 1983, the 54th ASG occupied the equivalent of four full floors of the office tower (Building 22) all as administrative space; a portion of Building 1 was being remodeled for administrative space and a small portion of the warehouse was being utilized for recreation (volleyball). The remainder of the facility is either still carpet manufacturing/storage or is vacant. The 54th ASG was in the process of planning utilization of the entire facility. Generally, it is proposed that Buildings 22, 1, 2, and 3 continue as administrative, and the warehouse/manufacturing space be converted to a mix-use facility including:

- Commissary - PX
- Maintenance
- Warehouse
- Recreation
- Other Community Facilities

2. EXISTING ENERGY SITUATION

2.1. Baseline FY 75 Energy Consumption.

The 54th ASG is billed for utility use based on total square footage leased. There is, therefore, no consumption data available either "Base Line" or current.

2.2. Source Energy Consumption.

Current rates are influenced by partial occupancy of the total complex and the demand/consumption ratio of the carpet manufacturing operation. The following basis for charges were obtained from Herr Kessler of Reichel Corporation in February 1983:

<u>Steam</u>	<u>DM/METRIC TON</u>	<u>US\$/1,000 LBS. at 2.4 DM/US\$</u>
Gas	33.41	6.32
Capital	3.86	.73
Material	3.33	.63
Labor	<u>5.60</u>	<u>1.06</u>
TOTAL	46.20	8.74
<u>Electricity</u>	<u>DM/KW HR</u>	<u>US\$/KWHR at 2.4 DM/US\$</u>
	0.18	0.075

2.3. Present Annual Energy Consumption.

Based on the building construction data obtained during the site survey, heating loads and annual heat consumption were estimated. Annual heat consumption was calculated using the modified degree-day method.

2.4. Existing Building Source Energy Consumption.

Calculations were first made with existing materials. The calculation assumes the building is heated as follows:

Administration: 68° F. Day, 63° F. Night

Community Facilities: 68° F. Day, 63° F. Night

Operations/Training: 68° F. Day, 63° F. Night

Maintenance Shops: 60° F. (Average)

Warehousing: 55° F. (Average)

The results are shown in Table 2-1. This shows the peak Heat Loss (HL) for each component of each building in BTUH; the peak HL for the building (TOTHLOS) in BTUH; the annual HL for the building (ANUALHT) in MBTU/YR and the annual HL per square foot of building per year in BTU/SF/YR (HTPSFYR). This shows that, without improvements to the envelope and with reuse of the existing mechanical systems, the annual heating consumption would be 55,233 MBTU. It also shows a peak heating load requirement of 19 million BTU/HR. Under these conditions, cost of natural gas would be approximately \$379,000/YR.

Table 2-1. Building Heat Loss

BLDG	HLWALL	HLROOF	HLGLAS	HLDOOR	TOTHLOS	ANUALHT	HTPSFYR
01	43,217	157,031	148,275	967	349,492	688	61,858
02	33,824	795,104	114,161	5,592	948,683	2,994	115,396
03	56,461	142,338	17,681	2,309	218,791	398	168,610
04	29,195	31,985	953	519	62,654	197	46,431
05	193,070	1,086,344	117,139		1,396,553	4,408	36,480
06	52,515	478,686			531,201	1,677	31,490
07A		244,691			244,691	772	56,754
07B	63,838	266,947	19,542	1,039	351,367	1,109	74,703
09	135,434	293,626	48,367	519	477,948	1,508	46,189

Table 2-1. Building Heat Loss (continued)

BLDG	HLWALL	HLROOF	HLGLAS	HLDOOR	TOTHLOS	ANUALHT	HTPSFYR
10	215,904	234,067	38,550	14,327	502,849	1,587	60,966
11	141,319	306,408	50,461		498,189	1,572	46,140
12		600,628			600,628	1,896	56,754
13	9,777	1,170,299		1,039	1,181,116	3,728	57,279
14	15,573	1,087,279			1,102,852	3,481	57,567
16A	109,863	1,072,411	5,257	4,355	1,191,888	3,762	63,077
16B	180,437	46,050	60,902		287,390	566	53,192
16C		1,072,411			1,072,411	3,385	56,754
18	306,734	1,786,963	24,730	37,142	2,155,571	6,805	68,462
19	79,652	702,183		5,048	786,883	2,484	63,600
20	41,661	306,408		1,905	349,975	1,104	64,824
21	508,890	399,526	54,067	9,329	971,814	3,068	19,489
22	1,476,407	309,598	2,107,809	16,551	3,910,366	7,708	24,702
24	16,658	22,179	52,889	2,901	94,628	186	118,572
25	6,546	5,767	9,608	7,943	29,866	94	103,726
31	3,753	10,067			13,821	43	77,915
TOTAL KASERNE ANUALHT IN MILLION BTUS							55,233
TOTAL KASERNE SQUARE FEET							1,256,027
AVERAGE ANNUAL BTU/SF							65,237
PEAK HEAT LOSS IN BTU							19,331,639

2.5. Revised Occupancy Energy Consumption.

Heating requirements were recalculated assuming a change in occupancy, generally in accordance with the community's April 1983 proposal. The occupancy of Buildings 6, 9, 10, 11, 13, 16C and 21 are assumed to change from warehousing to either administration or community facilities. Annual consumption rises ten (10) percent, but the peak HL rises 25 percent as shown in Table 2-2.

Table 2-2. Building Heat Loss

BLDG	HLWALL	HLROOF	HLGLAS	HLDOOR	TOTHLOS	ANUALHT	HTPSFYR
01	43,217	157,031	148,275	967	349,492	688	61,858
02	33,824	795,104	114,16	5,592	948,683	2,994	115,396
03	56,461	142,338	17,681	2,309	218,791	398	168,610
04	29,195	31,985	953	519	62,654	197	46,431
05	193,070	1,086,344	117,139		1,396,553	4,408	36,480
06	70,020	638,249			708,269	2,263	42,499
07A		244,691			244,691	772	56,754
07B	63,838	266,947	19,542	1,039	351,367	1,109	74,703
09	300,964	652,503	107,484	1,154	1,062,106	2,160	66,149
10	479,787	520,149	85,666	31,839	1,117,442	2,273	87,311
11	141,319	306,408	50,461		498,189	1,572	46,140
12		600,628			600,628	1,896	56,754
13	21,728	2,600,665		2,309	2,624,702	5,340	82,031
14	15,573	1,087,279			1,102,852	3,481	57,567
16A	109,863	1,072,411	5,257	4,355	1,191,888	3,762	63,077
16B	180,437	46,050	60,902		287,390	566	53,192
16C		2,383,137			2,383,137	4,848	81,279
18	306,734	1,786,963	24,730	37,142	2,155,571	6,805	68,462
19	79,652	702,183		5,048	786,883	2,484	63,600
20	41,661	306,408		1,905	349,975	1,104	64,824
21	1,130,868	887,837	120,150	20,731	2,159,588	4,393	27,911
22	1,476,407	309,598	2,107,809	16,551	3,910,366	7,708	24,702
24	16,658	22,179	52,889	2,901	94,628	186	118,572
25	6,546	5,767	9,608	7,943	29,866	94	103,726
31	3,753	10,067			13,821	43	77,915
TOTAL KASERNE ANUALHT IN MILLION BTUS							61,558
TOTAL KASERNE SQUARE FEET							1,256,027
AVERAGE ANNUAL BTU/SF							69,838
PEAK HEAT LOSS IN BTU							24,649,544

3. ENERGY CONSERVATION OPPORTUNITIES DEVELOPED

3.1. ECOs Investigated.

Under the current occupancy arrangement, no projects would qualify under the Energy Conservation Investment Program, even after this facility is purchased. The vast majority of the space which is now vacant, will be subject to design of new functional arrangements as well as new heating, ventilating, and lighting systems. There are some relatively minor modifications which will produce savings. These are covered in Section 3.3.

3.1.1. Increment 'F' - Maintenance and Repair.

Except for the office heating system and certain areas containing unit heaters, heating, and ventilating systems in the storage and manufacturing spaces should not be reused; rather new systems, specifically designed and zoned for the new occupancies should be provided.

For example, under one occupancy proposal, Building 16 would be occupied by PX, PX warehouse, clothing sales, foodland, laundry and tailor shop, and various recreational facilities. Most of these spaces will have a high enough internal heat gain to offset the heat loss through the roof. If they are heated and ventilated by the existing central systems most spaces will not only be overheated, but because of the location of the hot duct in the roof structure at the base of the skylight the rate of heat loss will be increased by promoting circulation of the cool air within the vault.

3.1.2. Weatherization Project.

Under any condition of occupancy, however, improvement in the thermal characteristics of the building can be recommended. Only the elimination of the skylights is subject to future design considerations. Using the previous example, the skylights would be desirable in the PX, PX warehouse, and clothing sales but must be eliminated from the theatre. Evaluation of ECO relating to building envelope, resulted in the following project qualifying under ECIP criteria:

PROJ. NO.	DESCRIPTION	\$ COST	SAVINGS (MBTU)	SIR
W-1	Weatherization Walls and Roofs	1,460,035	46,715	2.07

During the field survey of this facility, eight different types of walls and ten different types of roofs were identified. Each wall and roof type was analyzed and a modification for each was proposed to (wherever practical) achieve "U" factors required by current criteria. Cost estimates were developed for each modification. Unit prices and revised "U" factors were used to compute costs and savings. All buildings having SIRs less than 1.0 were eliminated.

The walls and roofs modifications having SIRS equal to or greater than one (1) are shown in Tables 3-1 and 3-2. While wall and roof insulation has been combined into a single insulation project, walls and roofs in the same building do not necessarily always qualify economically and therefore are listed separately.

SAVINGS	HEAT MBTU	FUEL
Walls	3,197	4,567
Roofs	29,504	42,148
TOTAL	32,601	46,715
COST		
Walls	\$ 231,791	
Roofs	1,154,513	
TOTAL	\$1,386,304	
SIR = 2.07		

Table 3-1. Savings Weatherization Walls

BLDG	KASERNE	FUNCTION	WALL TYPE	SQFT BLDG	SAVINGS MBTU	SAVINGS US\$	COST US\$	SIR	FUEL TYPE	SQFT WALL
03	RHEINB	OPERATIONS	CON2	2,366	73	6,466	6,221	1.03	NAT GA	1,793
09	RHEINB	COMMUNITY F	CON1	32,667	449	39,372	29,624	1.32	NAT GA	8,538
10	RHEINB	COMMUNITY F	CON1	26,039	715	62,766	47,227	1.32	NAT GA	13,611
13	RHEINB	COMMUNITY F	CON2	65,098	31	2,777	2,394	1.16	NAT GA	690
16B	RHEINB	ADMINISTRAT	CON2	10,650	254	22,342	19,881	1.12	NAT GA	5,730
21	RHEINB	COMMUNITY F	CON2	157,418	1,648	144,526	124,606	1.15	NAT GA	35,912
24	RHEINB	ADMINISTRAT	CON2	1,573	23	2,061	1,835	1.12	NAT GA	529
TOTAL ANNUAL HEAT SAVINGS MBTU										3,197
TOTAL DOLLAR SAVINGS										280,314
TOTAL COST										231,791
TOTAL SQFT										295,811
TOTAL SQFT WALLS										66,803
PEAK LOAD REDUCTION										1,579,945

Table 3-2. Savings Weatherization Roofs

BLDG	KASER	FUNC	ROOF TYPE	SQFT BLDG	SAVINGS MBTU	SAVINGS US\$	COST US\$	SIR	FUEL TYPE	SQFT ROOF
01	RHEINB	ADMIN	ATT2	11,137	237	20,807	6,831	3.04	NAT GA	11,137
02	RHEINB	WHSE	MET1	25,954	2,353	206,334	64,747	3.18	NAT GA	29,370
03	RHEINB	OPER	MET1	2,366	243	21,334	5,215	4.09	NAT GA	2,366
04	RHEINB	WHSE	CON3	4,260	86	7,606	3,756	2.02	NAT GA	2,130
05	RHEINB	WHSE	CON5	120,856	2,340	205,187	106,573	1.92	NAT GA	60,428
06	RHEINB	SHOPS	CON5	53,254	1,391	122,022	46,960	2.59	NAT GA	26,627
07A	RHEINB	WHSE	CON5	13,611	527	46,218	24,004	1.92	NAT GA	13,611
07B	RHEINB	WHSE	CON5	14,849	575	50,420	26,188	1.92	NAT GA	14,849
09	RHEINB	COMTY	CON5	32,667	905	79,426	28,805	2.75	NAT GA	16,333
10	RHEINB	COMTY	CON5	26,039	722	63,316	22,962	2.75	NAT GA	13,020
11	RHEINB	WHSE	CON5	34,087	660	57,874	30,059	1.92	NAT GA	17,044

Table 3-2. Savings Weatherization Roofs (continued)

BLDG	KASER	FUNC	ROOF TYPE	SQFT BLDG	SAVINGS MBTU	SAVINGS US\$	COST US\$	SIR	FUEL TYPE	SQFT ROOF
12	RHEINB	WHSE	CON5	33,410	1,293	113,446	58,923	1.92	NAT GA	33,410
13	RHEINB	COMTY	CON5	65,098	3,610	316,565	114,809	2.75	NAT GA	65,098
14	RHEINB	WHSE	CON5	60,480	2,342	205,364	106,664	1.92	NAT GA	60,480
16A	RHEINB	WHSE	CON5	59,653	2,310	202,556	105,206	1.92	NAT GA	59,653
16B	RHEINB	ADMIN	ATT1	10,650	80	7,094	3,266	2.17	NAT GA	2,130
16C	RHEINB	COMTY	CON5	59,653	3,308	290,098	105,206	2.75	NAT GA	59,653
18	RHEINB	WHSE	CON5	99,400	3,849	337,520	175,305	1.92	NAT GA	99,400
19	RHEINB	WHSE	CON5	39,059	1,512	132,627	68,886	1.92	NAT GA	39,059
20	RHEINB	WHSE	CON5	17,044	660	57,874	30,059	1.92	NAT GA	17,044
22	RHEINB	ADMIN	CON1	312,040	424	37,223	17,568	2.11	NAT GA	28,640
24	RHEINB	ADMIN	WD1	1,573	33	2,938	964	3.04	NAT GA	1,573
25	RHEINB	WHSE	WD1	909	13	1,224	557	2.19	NAT GA	909
31	RHEINB	WHSE	CON5	560	21	1,901	987	1.92	NAT GA	560

TOTAL ANNUAL HEAT SAVINGS MBTU	29,504
TOTAL DOLLAR SAVINGS	2,586,984
TOTAL COST	1,154,513
TOTAL SQFT	1,098,609
TOTAL SQFT ROOFS	674,524
PEAK LOAD REDUCTION	11,038,358

3.1.3. Mechanical Control.

Generally, manual radiator valves are used in buildings heated with radiators. This type of heating control does not rely on a temperature measurement within the space, but instead is left to the occupants. As additional space in the building is acquired, new radiators should be equipped with automatic valves. Before weatherization, existing manual valves in Buildings 1, 2, 3, and 4 should be replaced by thermostatic radiator valves on all radiators. Since the cost will not exceed \$200,000., it does not qualify as an ECIP project. This project may be funded however, through the military community authority. Therefore, documentation for thermostatic valves of occupied buildings may be found in Section 3.3.

3.1.4. Night Setback of Space Temperature in Occupied Buildings.

Night setback through installation of water temperature reset is included in the ECO recommended in Section 3.1.5. Utilizing Boilers in Building 21 for Facility Heating Requirements.

3.1.5. Boiler Plants.

Hot water for space heating and steam for process loads (carpet manufacturing) are presently supplied from two large boilers in Building 8, producing steam at 440 psig. The boiler normally in operation (assumedly because it is the most efficient) has a nominal capacity of 44,000 LB/HR.

A second boiler plant in Building 21 contains two hot water boilers, each having a capacity of seven (7) MBTU. This plant was installed to serve heating and process hot water loads in Building 21 only and is presently not used because Building 21 is vacant.

Because neither plant was under Government control at the time of the investigation (only the 44,000 LB/HR steam boiler was operating) no boiler efficiency tests are available. Estimates of combustion efficiencies based on experience with similar sized equipment must be used. Make up feed water to the steam plant was determined to be ten percent.

3.1.5.1. Heating Requirements.

The peak heating demand has been calculated to be 13.6 million BTU/HR. The average demand will be approximately 50 percent or 6.8 MBTUH. On a seasonal average, the main boiler in Building 8 would be operating at 15 percent of full load or its alternate (22,000 LB/HR) at 30 percent of capacity.

The boilers in Building 21 would operate between 50 and 100 percent of full load. The annual net heating requirement has been estimated to be approximately 32,000 MBTU/YR.

3.1.5.2. Plant Performance.

Comparison of the performance of the plants can be estimated as follows based on reasonable assumptions of efficiencies:

Boiler No. 1: B-1 Steam 44,000 LB/HR at 440 psig.
 Boiler No. 2: B-2 Steam 44,000 LB/HR at 440 psig.
 Boiler No. 3 and 4: B-3 Hot water seven (7) MBTU each.

	B-1	B-2	B-3 AND B-4
Efficiency	80 percent	77 percent	75 percent (1)
Condensate Losses	10 percent	10 percent	0 percent (2)
Radiation Losses	7 percent	4.8 percent	NIL (3)
Blowdown	1 percent	1 percent	0 percent
Conduction & Distribution	<u>5</u> percent	<u>5</u> percent	<u>5</u> percent (4)
Net Seasonal Efficiency	57 percent	56.2 percent	70 percent

(1) Ruhrkohle - Handbook

(2) Operating Log

(3) American Boiler Manufacturers Association Standard Curve

(4) Assume Equal

3.1.5.3. Economic Analysis.

The boilers in Building 21 were each sized to handle the full load of Building 21 including a very large ventilation load. One boiler is equipped to burn only natural gas; the other equipped only to burn No. 2 fuel oil. Natural gas is the normal fuel. The large steam plant in

Building 8 normally burns gas and must switch to oil only when the outdoor temperature is below 32° F. It has been assumed that oil standby will also be required for the smaller plant in Building 21. A lower change-over temperature should be required for the smaller plant so that the actual amount of oil burned per year is assumed to cause a negligible difference in annual energy costs. To provide the capability to burn either natural gas or oil requires replacement of the existing burner with combination gas/oil burner plus minor extension of gas and fuel oil piping.

The plant in Building 21 presently has hot water distribution piping to equipment only in Building 21. New distribution piping and pumping capacity must be added between this plant and the main hot water distribution system in Building 6 in order to supply the entire complex. In addition, outdoor reset controllers have been added to reset water temperature as a function of outdoor temperature and also to set back nighttime hot water temperatures. The cost of this work as shown in the detailed estimated is \$290,447.

Based on estimated seasonal efficiencies of 57 percent for Boiler Plant No. 8 and 70 percent for Boiler Plant No. 21, and the net heating requirement of 32,000 MBTU, fuel consumption would be:

No. 8 Steam Plant: $32,000 / .57 = 56,140$ MBTU

No. 21 Hot Water Plant: $32,000 / .70 = 45,714$ MBTU

Savings From Hot Water Plant: 10,426 MBTU/YR

Savings in Natural Gas Cost: $\$4.80/\text{MBTU} * 10,426 = \$50,044$

Discounted Dollar Savings (15-year) = $50,044 * 12.8 = \$640,563$

SIR = $640,563 / (290,447 * 0.9 * 1.055) = 2.32$

3.1.6. Energy Monitoring and Control Systems.

3.1.6.1. General.

The feasibility of installing an Energy monitoring and Control System for the portion of the facility presently occupied by the USAEUR was investigated as part of this study. The Master Control Room (MCR) is proposed to be located on the ninth floor of Building 22 in the facility engineering department. The system would have 4 Field Interface Devices (FIDs) and 6 multiplexers (MUXs) located strategically throughout the occupied building to monitor and control points and functions in Buildings 1, 2, 3, 4, 5, 6, 24, 25, and the boiler room in Building 21. The system has been estimated to contain 140 points and is therefore classified as a small system.

3.1.6.2. Software Functions.

The following software functions have been selected for the EMCS on the basis that local controls as described have first and EMCS has second priority. This means that the savings gained by EMCS are based on the annual heating consumption after the deduction of those savings gained by local controls.

3.1.6.3. Scheduled Start/Stop.

This function will not result in any further energy savings, other than those already gained by local controls.

3.1.6.4. Summer/Winter Operation.

This function will shut down heating systems during periods where outdoor temperature is above 59°F. (15°C.). Based on a computer simulation, a savings of 3.5 percent of annual heating energy could be realized.

3.1.6.5. Optimum Start/Stop.

Experience has shown that this function will result in additional annual shut-off periods of approximately 0.5 hours/day over the year, which results in 183 hours/year, with an annual 3.5 percent/2,394 hours \times 183 hours = 0.27 percent.

The electrical energy savings constant will be 183 hours \times 30 kW = 5,490 kWh/year for shut-off of each hot water circulating pump. For each heating and ventilating unit fan the electrical savings constant will be 183 hours \times 15 kW = 2,745 kWh/YR.

3.1.6.6. Duty Cycle.

No savings can be gained for the type of buildings in this facility.

3.1.6.7. Day/Night Setback.

This function will not result in any further energy savings, other than those already gained by local controls.

3.1.6.8. Lighting Controls.

The total annual lighting consumption of Buildings 1, 2, 3, 4, 5, 6, 22, 24, and 25 is 477,133 kWh/YR. Experience has shown that local time clock controls will be by-passed by overriding controls in many cases and that only a centralized EMCS control function will drastically reduce lighting consumption. It will be assumed that the electrical energy savings gained by this function will be eight percent.

3.1.6.9. Maintenance Function.

The EMCS will provide continuous information over the status of the entire systems connected to it. It will instantaneously annunciate if local control functions are in override (Hand) position, if pumps or control valves are in functional operation and will save energy and maintenance effort for this reason.

Experience shows that the percentage of control panels being in override (hand) position is much higher, especially after drastic energy conservation measures such as room temperature reductions in administrative buildings to 18°C./65°F., have been implemented. For these reasons, this study uses a savings constant of five percent for overall savings by better and instantaneous maintenance and monitoring capability.

3.1.6.10. Summary of Savings Constants.

FUNCTION	HEATING ENERGY	ELEC. ENERGY
=====		
Summer/Winter Operation (Heat)	3.5 percent	
Optimum Start/Stop	(Heat) 0.27 percent	5,490 kWh/YR/pump 2,745 kWh/YR/fan
Lighting Control		Eight (8) percent
Maintenance	5.0 percent	
Total Annual Savings:		
Heating Energy:	8.77 percent of consumption	
Lighting Energy:	8.0 percent of annual lighting	
Pump Electrical Energy:		5,490 kWh/YR/pump
Fan Electrical Energy:		2,745 kWh/YR/pump

3.1.6.11. Economic Analysis.

From Table 3-3., the annual heat loss is 10,443 million BTUs. The heating savings would therefore be $.0877 \times 10,443 = 915$ million BTU. From Table 3-4., the annual lighting consumption is 477,133 kWhrs. The annual savings would be $0.08 \times 477,133 = 38,170$ kWhrs.

Table 3-3. Building Heat Loss - Improved Envelope

BLDG	HLWALL	HLROOF	HLGLAS	HLDOOR	ANUALHT
01	43,217	36,640	148,275	967	451
02	33,824	49,694	114,161	5,592	641
03	56,461	8,896	17,681	2,309	155
04	29,195	4,504	953	519	111
05	193,070	345,074	117,139		2,068
06	70,020	202,737			871
22	1,476,407	94,225	2,107,809	16,551	7,283
24	16,658	5,175	52,889	2,901	153
25	6,546	1,345	9,608	7,943	80
TOTAL ANUALHT IN MILLION BTUS					10,443
TOTAL SQUARE FEET					532,349

Table 3-4. Electric Cons by Lighting

BLDG	USE	SQFT	WPSF	KWDEM	OCCUP	LKWH	BTUSFYR
01	ADMIN	11,137	.74	8	2,860	23,881	7,316 FLUO
02	WHSE	25,954	.75	19	2,860	55,684	7,320 FLUO
03	SERVICES	2,366	.75	1	2,860	5,090	7,341 FLUO
04	WHSE	4,260	.75	3	2,860	9,152	7,330 FLUO
05	WHSE	120,856	.75	90	2,860	259,459	7,325 FLUO
06	WHSE	53,254		40	2,860	115,315	7,388 FLUO
22	ADMIN	312,040			2,860		FLUO
24	GUARD HOUSE	1,573	1.74	2	2,860	7,865	17,060 FLUO
25	GARAGE	909	.26		2,860	686	2,576 INCD
TOTAL KASERNE LIGHTING CONS IN KWHR							477,133
TOTAL KASERNE SQUARE FEET							532,349
TOTAL LIGHTING DEMAND IN KW							166

The pumping savings would be $2 \times 5,490 = 10,980$ kWhrs.

The fan energy savings would be $4 \times 2,745 = 10,980$ kWhrs.

Total Electrical Savings = 60,130 kWhrs/YR.

From the cost estimate, the construction cost of the EMCS system is \$440,575.

The SIR is 0.30 and thus does not qualify for ECIP.

3.2. ECIP Projects Developed.

Two (2) Life Cycle Cost Analysis Summaries yielded ECIP projects with an SIR greater than one (1). They are:

Boiler Modifications - SIR = 2.32

Weatherization - SIR = 2.07

The Life Cycle Cost Analysis Summary and Form 1391 are in this Section.

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Rheinberg, FRG REGION NO. PROJECT NUMBER
PROJECT TITLE Boiler Modifications FISCAL YEAR 1987
DISCRETE PORTION NAME Efficiency Improvement
ANALYSIS DATE 1983 ECONOMIC LIFE 15 YEARS PREPARED BY LAD

1. INVESTMENT

A. CONSTRUCTION COST	\$	290,447	
B. SIOH (at 5.5%)	\$	15,974	
C. DESIGN COST	\$	---	
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$	275,779	
E. SALVAGE VALUE	\$	---	
F. TOTAL INVESTMENT (1D-1E)			\$ 275,779

2. ENERGY SAVINGS (+)/COST (-)
ANALYSIS DATA ANNUAL SAVINGS, UNIT COST AND DISCOUNTED SAVINGS

FUEL	COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$		\$		\$
B. DIST	\$		\$		\$
C. RESID	\$		\$		\$
D. NG	\$ 4.80	10,426	\$ 50,044	12.80	\$ 640,563
E. COAL	\$		\$		\$
F. TOTAL		10,426	\$ 50,044		\$ 640,563

3. NON ENERGY SAVINGS (+)/COST (-)

A. ANNUAL RECURRING (+/-) \$ 0
 (1) DISCOUNT FACTOR (TABLE A)
 (2) DISCOUNTED SAVING/COST (3A X 3A1) \$ 0

B. NON RECURRING SAVINGS (+)/COST (-)

ITEM	SAVINGS (+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS (+) COST (-)(4)
a. <u> </u>	\$			\$
b. <u> </u>	\$			\$
c. <u> </u>	\$			\$
d. TOTAL				\$ 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+)/COST (-) (3A2+3Bd4) \$ 0

4. FIRST YEAR DOLLAR SAVINGS $2F2+3A+(3B1d/YEARS\ ECONOMIC\ LIFE)$ \$ 50,044

5. TOTAL NET DISCOUNTED SAVINGS $(2F3+3C)$ \$ 640,563

6. DISCOUNTED SAVINGS RATIO (IF LESS THAN 1 PROJECT DOES NOT QUALITY)
 $(SIR)=(5/1F) =$ 2.32

7. ECIP QUALIFICATIONS TEST

A. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC $(2F3 \times .33)$ \$ 0

(2) NON ENERGY DISCOUNTED SAVINGS $(3C)$ \$ 0

(3) ENTER SMALLER OF 7.A.1 OR 7.A.2 \$

$ESIR = (2F3 + 7A3)/1F =$ 2.32

IF LESS THAN 1 PROJECT DOES NOT QUALIFY FOR ECIP

IF GREATER THAN 1 THEN PROJECT QUALIFIES FOR ECIP

AND THE "SIR" GENERATED IN 6. IS REPORTED AS THE PROJECT "SIR".

1. COMPONENT ARMY		FY 19 ⁸⁷ MILITARY CONSTRUCTION PROJECT DATA			2. DATE 1 MAY 1984	
3. INSTALLATION AND LOCATION 54th Area Support Group, Rheinberg, FRG				4. PROJECT TITLE ECIP - BOILER PLANT MODIFICATION		
5. PROGRAM ELEMENT MCA - ECIP		6. CATEGORY CODE 80000	7. PROJECT NUMBER		8. PROJECT COST \$390.9	
9. COST ESTIMATES						
ITEM		1.00 \$ = 2.56 DM	U/M	QUANTITY	UNIT COST	COST
Combination Natural Gas/Oil Burners			EA	2	8,500	17.0
Gas Piping 2-1/2 Inch Black Steel			LF	50	17.90	1.4
Gas Train and Fittings			EA	1	3,156	3.2
Fuel Oil Piping 3/4 Inch			LF	50	7.90	.4
Fuel Oil Pump Valves & Fittings			LS	1	3,156	3.2
Hot Water Piping 8 Inch Black Steel			LF	2,300	93.30	214.6
Hot Water Valves and Fittings			LS	1	11,870	11.9
Hot Water Circulating Pump 500 GPM			EA	2	3,130	6.3
Hot Water Pipe Insulation 1-1/2 Inch			LF	2,300	12.15	27.9
Outside Air Reset Control			EA	1	4,800	4.8
Electrical Connections (HWP)			EA	2	1,490	3.0
Electrical Connections Fuel Oil Pump			EA	1	610	.6
SUBTOTAL						294.3
Contingency (5.0 Percent)						14.7
SUBTOTAL						309.0
Cost Growth (19.9 Percent)						61.5
Total Contract Cost						370.5
Supervision Insp. + OHead (5.5 Percent)						20.4
TOTAL REQUEST						390.9
10. DESCRIPTION OF PROPOSED CONSTRUCTION						
<p>This project is to modify two 7 million BTU existing hot water heating boilers so that they both are able to burn either natural gas or fuel oil. Currently one burns only gas and one only oil. The project will also extend the existing hot water heat distribution system to adjacent areas of the building. Design is special because of modification to an existing system. The project will eliminate the heating load on the existing high pressure steam boiler plant which also burns both natural gas and, when required by the gas supplier, oil. There is no air conditioning involved. All required utilities presently exist. The building is not located in a flood plain and no demolition is required. The handicapped will not be provided for since this project does not lend itself to design for the handicapped.</p>						
11. Requirement.						
ECIP EEAP Package 14, SIR = 2.32						

LIFE CYCLE COST ANALYSIS SUMMARY
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)

LOCATION: Rheinberg, FRG REGION NO. _____ PROJECT NUMBER _____
PROJECT TITLE Weatherization FISCAL YEAR 1987
DISCRETE PORTION NAME Wall and Roof Insulation
ANALYSIS DATE 1983 ECONOMIC LIFE 15 YEARS PREPARED BY LAD

1. INVESTMENT

A. CONSTRUCTION COST	\$	1,460,035	
B. SIOH (at 5.5%)	\$	80,301	
C. DESIGN COST	\$	---	
D. ENERGY CREDIT CALC (1A+1B+1C)X.9	\$	1,386,304	
E. SALVAGE VALUE	\$		
F. TOTAL INVESTMENT (1D-1E)			\$ 1,386,304

2. ENERGY SAVINGS (+)/COST (-)

ANALYSIS DATA ANNUAL SAVINGS, UNIT COST AND DISCOUNTED SAVINGS

FUEL	COST \$/MBTU(1)	SAVINGS MBTU/YR(2)	ANNUAL \$ SAVINGS(3)	DISCOUNT FACTOR(4)	DISCOUNTED SAVINGS(5)
A. ELEC	\$		\$		\$
B. DIST	\$		\$		\$
C. RESID	\$		\$		\$
D. NG	\$ 4.80	46,715	\$ 224,232	12.80	\$ 2,870,169
E. COAL	\$		\$		\$
F. TOTAL		46,715	\$ 224,232		\$ 2,870,169

3. NON ENERGY SAVINGS (+)/COST (-)

A. ANNUAL RECURRING (+/-) \$ 0
(1) DISCOUNT FACTOR (TABLE A)
(2) DISCOUNTED SAVING/COST (3A X 3A1) \$ 0

B. NON RECURRING SAVINGS (+)/COST (-)

ITEM	SAVINGS (+) COST (-)(1)	YEAR OF OCCURRENCE(2)	DISCOUNT FACTOR(3)	DISCOUNTED SAVINGS (+) COST (-)(4)
a. _____	\$			\$
b. _____	\$			\$
c. _____	\$			\$
d. TOTAL	\$			\$ 0

C. TOTAL NON ENERGY DISCOUNTED SAVINGS (+)/COST (-) (3A2+3Bd4) \$ 0

4. FIRST YEAR DOLLAR SAVINGS $2F2+3A+(3B1d/YEARS\ ECONOMIC\ LIFE)$ \$ 224,232
5. TOTAL NET DISCOUNTED SAVINGS $(2F3+3C)$ \$ 2,870,169
6. DISCOUNTED SAVINGS RATIO (IF LESS THAN 1 PROJECT DOES NOT QUALITY)
(SIR)=(5/1F) = 2.07

7. ECIP QUALIFICATIONS TEST

A. PROJECT NON ENERGY QUALIFICATION TEST

(1) 25% MAX NON ENERGY CALC $(2F3 \times .33)$ \$ 0

(2) NON ENERGY DISCOUNTED SAVINGS (3C) \$ 0

(3) ENTER SMALLER OF 7.A.1 OR 7.A.2 \$

$$ESIR = (2F3 + 7A3)/1F = \underline{2.07}$$

IF LESS THAN 1 PROJECT DOES NOT QUALIFY FOR ECIP

IF GREATER THAN 1 THEN PROJECT QUALIFIES FOR ECIP

AND THE "SIR" GENERATED IN 6. IS REPORTED AS THE PROJECT "SIR".

1. COMPONENT ARMY		FY 19 <u>87</u> MILITARY CONSTRUCTION PROJECT DATA			2. DATE 1 May 1984	
3. INSTALLATION AND LOCATION 54th Area Support Group, Rheinberg, FRG			4. PROJECT TITLE ECIP - Weatherization			
5. PROGRAM ELEMENT MCA, ECIP		6. CATEGORY CODE 80000	7. PROJECT NUMBER		8. PROJECT COST \$1,921	
9. COST ESTIMATES						
ITEM		1.00 \$ = 2.56 DM	U/M	QUANTITY	UNIT COST	COST
Wall Types CON1 and CON2						
1 x 2 furring strips			SF	66,803	0.52	34.7
1/2 inch rigid insulation			SF	66,803	0.76	50.8
Vapor Barrier			SF	66,803	0.16	10.6
1/2 inch gypsum wallboard			SF	66,803	1.28	85.5
Paint			SF	66,803	0.90	60.1
Roof Type CON1, ATT2 and WD1						
3-1/2 inch blanket insulation			SF	42,259	0.64	27.0
Roof Type CON3 and CON5						
2 inch spray-on cementitious insul.			SF	598,399	1.84	1,101.1
Roof Type MET1: 2-1/2 inch spray insul.			SF	31,736	2.30	73.0
Roof Type ATT1: 5 inch blown perlite ins.			SF	2,130	1.60	3.4
Subtotal						1,446.3
Contingency (5.00 percent)						72.3
Subtotal						1,518.6
Cost Growth (19.9 percent)						302.2
Total Contract Cost						1,820.8
Supervision Insp. & Ohead (5.5 percent)						100.2
Total Request						1,921.0
Installed Equipment - Other Approp.						(0)
10. DESCRIPTION OF PROPOSED CONSTRUCTION						
<p>This project is to insulate 66,803 sq. ft. of uninsulated walls and 674,524 sq. ft. of poorly insulated roofs in 26 permanent buildings. Design is special to accommodate the differing existing wall conditions. Project will reduce load on the existing heating system. There is no air conditioning involved. All required utilities presently exist. The buildings are not located in a flood plain and no demolition is required. The handicapped will not be provided for since this project does not lend itself to design for the handicapped.</p>						
<p>11. <u>Requirement.</u> 741,327 SF: Adequate: 0 Substandard: 741,327 SF ECIP Project, EEAP Package 14 SIR = 2.07</p>						
<p><u>Project.</u> Provision of wall and roof insulation of uninsulated walls and roofs and on roofs with inadequate insulation.</p>						

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3.3. Other Energy Conservation Projects Developed.

3.3.1. Maintenance and Repair Projects.

If the USAEUR takes control of this facility, there are maintenance and repair projects that would provide some energy savings. These are summarized as follows:

PROJECT	COST	ANNUAL SAVINGS		SIR
		MBTU	\$US	
Replace Manual Valves	\$1,176	297	1427	10.6
Window Gasket Maint.	4,122	480	2324	1.94
Weatherstrip Doors	<u>3,258</u>	<u>139</u>	<u>669</u>	1.18
TOTAL	\$8,556	916	4420	

3.3.1.1. Replace Manual Radiator Valves.

Generally, manual radiator valves are used in buildings heated with radiators. This type of heating control does not rely on a temperature measurement within the space, but instead is left to the occupants. Often, instead of closing the valve when the room starts to overheat, the occupant will open the windows. Thermostatic control valves provide a much better means of regulation by automatically opening and closing as required to meet the space heating load.

Cost and savings are based on an 8-year life because it is assumed that the valves will be defective at the end of eight years.

Buildings 1 and 3 contain a total of 28 valves that can be replaced with thermostatic control valves.

Costs. Thermostatic control valves can be purchased for \$17. each and will require one hour for installation at \$25/HR.

Total Cost/Valve = \$42

Total Cost = 28 * \$42 = \$1,176

- Savings. From building list, Building 1 is found to have an annual consumption of 1,076 MBTU and Building 3 annual consumption of 623 MBTU. However, approximately one half of heat to Building 3 is provided by unit heaters.

$$\text{Total consumption} = 1,076 + (623/2) = 1388 \text{ MBTU}$$

The degree-day correction factor for thermostatic valves is found to be 0.15 (15 percent annual savings)

$$\text{Total savings} = 1388 * 0.15 = 208 \text{ MBTU}$$

Assuming 70 percent boiler efficiency, fuel savings would be $208/.7 = 297 \text{ MBTU}$.

$$\text{Cost saving} = 297 * \$4.80/\text{MBTU} = \$1,427.$$

$$\text{Discounted Savings (8-year)} = 1,427 * 7.86 = 11,216$$

$$\text{SIR} = 11,216 / (1,176 * .9) = 10.6$$

3.3.1.2. Window Gasket Maintenance.

Building 22 has 810 operable windows with neoprene gaskets. These gaskets when in good repair provide excellent seals against infiltration. The gaskets, however, become unglued and dry out. When this occurs, occupants resort to the use of portable electric heaters. There are approximately 12,454 LF of gaskets to be maintained.

- Assumptions:

Repair every three years or 4,150 LF/YR.

15 LF/window and 1/2 HR labor per window at \$25 = 12.50

20% material failure requiring replacement at \$.80/LF = \$2.40/Window

Average reduction in infiltration = 25 CFH/LF

Average temperature difference to office space = 30° F.

- Costs:

$$$/YR = (12.50 \text{ labor} + 2.40 \text{ MAT})/15 \text{ LF} * 4,150 \text{ LF} = \$4,122$$

- Savings (Similar to 6.1.1.)

$$\text{BTU/YR/LF} = (25 * .075 * .24 * 30 * 250 * 24)/.7 = 115,714$$

$$$/YR/LF = (115,714/1,000,000) * 4.80 = \$.56/\text{YR/LF}$$

$$\text{Total Savings MBTU/YR} = .1157 * 4,150 \text{ LF} = 480 \text{ MBTU}$$

$$\text{Total Savings } \$/YR = \$.56 * 4,150 \text{ LF} = \$2,324$$

$$\text{Discounted Dollar Savings (3-year LIFE)} = 2,324 * 3.1 = \$7,204$$

$$\text{SIR} = 7,204/(4,122 * .9) = 1.94$$

3.3.1.3. Weatherstrip Doors.

There are 37 single and five (5) double personnel doors that require new weatherstripping. In addition, there are 16 overhead doors that require door seals.

- Costs: Personnel doors: 905 LF at 3.60 = \$ 3,256

$$\text{Overhead doors: } 967 \text{ LF at } 10.40 = \$10,056$$

- Savings: Reduce infiltration in personnel doors from 77 to 27 CFH/LF = 50 CFH/LF and in OH doors from 122 to 27 CFH/LF = 95 CFH/LF
Saving

Assume: Average temperature difference = 200 F.

Heating Days = 250

Plant Efficiency = .70

Cost/MBTU = \$4.80

LBS Air/CFH = .075

BTU/LB Air/Degree F. = .24

$$\text{Savings (BTU)} = (\text{CFH} * \text{LB}/\text{CF} * \text{BTU}/\text{LB}/\text{DF} * \text{DT} * \text{Days} * \text{HR}/\text{Day})/\text{efficiency}$$

$$\text{Savings Personnel Doors} = (50 * .075 * .24 * 20 * 250 * 24)/.7 = 154,285$$

$$\text{BTU/LF}$$

Cost Savings Personnel Doors = $154,285 / 1,000,000 * \$4.80 = \$0.74/LF$

Total Personnel Door Savings:

BTU = $.154 \text{ MBTU/LF} * 905 \text{ LF} = 139.4 \text{ MBTU}$

\$ = $\$0.74/LF * 905 \text{ LF} = \669

Discounted Dollar Savings (5-year) = $5.18 * 669 = \$3,465$

SIR = $3,465 / (3,258 * .9) = 1.18$

Since overhead door costs are three times personnel doors costs and savings are only double, it is obvious that SIR will be less than one (1).

3.3.1.4. Disconnect Electric Space Heaters.

Private garages 27, 27A and 29 are equipped with electric heaters. These should be permanently disconnected since heating parking garages is not authorized.

3.3.2. Previous Energy Studies.

No previous energy studies have been performed on this facility.

3.3.3. Operational Improvements.

At the time of the investigation, operation was under the control of the Landlord.

3.3.4. Previously Implemented Energy Projects.

No energy conservation projects have been implemented at this facility.

3.3.5. Future Development Plans.

The 54th ASG does not have an approved "Future Development Plan". Studies and proposals are still in progress. This study has been to investigate the existing building assuming that the presently vacant space will eventually be occupied under some program of development.

3.3.6. Increment 'G'.

No Increment 'G' projects were identified at this community.

3.3.7. Other Energy Conservation Opportunities Examined.

3.3.7.1. Metering.

No buildings were identified where the addition of metering might be expected to reduce energy consumption.

3.3.7.2. Solar Energy.

This region of Europe is normally overcast during much of the year. Investigation of the use of solar energy is not warranted.

3.3.7.3. Inoperative Controls.

Most of the control systems in this facility were not being used since most of the space was vacant. Those in use all appeared to be functioning properly.

3.3.7.4. District Heat.

There is no District Heating System available to the facility.

3.3.7.5. Study the feasibility of peak demand shedding.

There are no shedable loads.

3.3.7.6. Insulating Glass.

Replacement of single pane with double pane glass had an SIR less than one (1).

3.3.7.7. Insulation of Walls.

Insulation of uninsulated walls is included in Weatherization ECIP. Other walls and roofs did not meet SIR criteria greater than one (1).

3.3.7.8. Zone existing multiple use facilities to reduce energy consumption in minimal use areas.

It is assumed that this will be done in design for the new occupancy.

3.3.7.9. Reschedule utilization of existing facilities.

Utilization of facility is still under study by 54th ASG.

3.3.7.10. Consolidate services into permanent buildings through alteration or new construction.

Still under study by 54th ASG.

3.3.7.11. Connect to district heating in order to purchase or sell energy.

District heat is not available.

3.3.7.12. Interconnect existing power plants.

Power plants recommendation is included in Boiler Modification ECIP.

3.3.7.13. Consolidate existing power plants where forecastable non-recurring maintenance costs can be demonstrated.

See Increment 'B'

3.3.7.14. Convert to more energy efficient fuels.

See Boiler Modification ECIP.

3.3.7.15. Insulate existing supply and return piping.

Existing piping is insulated.

3.3.7.16. Return condensate.

Condensate is returned.

3.3.7.17. Convert existing energy distribution systems to utilize more efficient medium.

See Boiler Modification ECIP.

3.3.7.18. Recover heat from processes such as boiler blowdown, refrigerant gas, exhaust air from laundries and messhalls, destratification of air.

None are applicable.

3.3.7.19. Supplement the generation of domestic hot water through installation of a heat pump.

No air conditioning is installed.

3.3.7.20. Decentralize domestic hot water heaters.

There are no domestic hot water heaters.

3.3.7.21. Curtail availability of energy to domestic hot water heaters.

There are no domestic hot water heaters.

3.3.7.22. Install shower flow restrictors.

There are no showers.

3.3.7.23. Improve street lighting efficiency by delamping (reduction of lighting level) or replacement with low or high pressure sodium.

There is no street lighting.

3.3.7.24. Relamp with fluorescent, H.P. sodium or other more energy efficient lighting.

Exterior lighting is fluorescent and sodium.

3.3.7.25. Control light levels automatically.

Variation in external luminance is insufficient to warrant automatic adjustment.

3.3.7.26. Utilize photocell switches.

These exist on outside lighting.

3.3.7.27. Replace incandescent lamps with fluorescent or H.P. sodium.

Incandescent lamps are only used for temporary lighting.

3.3.7.28. Utilize high efficiency ballasts.

Recommended for ballast replacement.

3.3.7.29. Employ spot heating in lieu of existing unit heaters.

Spot heating is not applicable to function.

3.3.7.30. Individual versus stairwell or area metering of military family housing.

There is no family housing.

3.3.7.31. Recommended preventive maintenance program procedures for high efficiency motor replacement.

There are no low efficiency motors.

3.3.7.32. Provide or improve existing controls such as thermostatic radiator valves, outside air reset, night setback, duty cycling and economizer cycles.

Thermostatic radiator valves and night setback are in Section 3.3.1.4.

3.3.7.33. Insulate basement ceilings, walls, attic floors and roofs.

See Weatherization ECIP.

3.3.7.34. Install caulking and weatherstripping.

See 3.3.1.1. and 3.3.1.2.

3.3.7.35. Install storm or energy efficient windows, double glaze existing windows, reduce window area, install translucent panels, upgrade by replacement, install thermal barriers, modify skylights.

See 3.3.12. and 3.3.13.

3.3.7.36. Replace existing doors, install vestibules, air curtains and load dock seals.

Not applicable.

3.4. Recommendations, Policy Changes and Actions.

3.4.1. Recommendations and Policy Changes.

The 54th ASG is charged a flat fee per square foot of occupancy for utilities. There is no baseline (FY 75) consumption history and the present situation continually changes as the 54th acquires more space.

If the 54th ASG acquires this property, they will have 312,000 square feet of administrative space and one million square feet of warehouse/-manufacturing space which is planned to be converted to multi-use space.

There are insulation deficiencies in both spaces. In all possible considerations of utilization, it would be beneficial to properly weatherize the facility. The existing high pressure boiler plant is grossly oversized for any near term needs of the Army. A secondary

boiler plant can be reactivated and distribution systems extended to replace the manufacturing plant's main boilers. There are other miscellaneous minor deficiencies. Projects for weatherization, boiler plant modification and energy monitoring and control systems were evaluated for possible inclusion in the ECIP. The EMCS project failed to qualify because of low savings to cost ratios.

3.4.2. Actions.

- 3.4.2.1. The ECIP and Maintenance and Repair projects should be implemented.
- 3.4.2.2. Individual mechanical and lighting systems should be designed for each multi-use occupancy. Existing factory ventilation systems would be inappropriate for heating.
- 3.4.2.3. The existing high pressure steam distribution system should be deactivated and not used for space heating.
- 3.4.2.4. The EMCS project should be re-evaluated after detailed design is completed for the final approved occupancy schedule.

4. ENERGY AND COST SAVINGS

4.1. Energy Consumption Forecast.

It is not possible to forecast future energy consumption because of the uncertainty of space ownership and utilization. This forecast will only be possible after detailed design is completed for the final approved occupancy.

4.2. Forecast Energy Savings.

The two (2) recommended ECIP projects will produce a total annual energy savings of 57,141 MBTU and the three (3) recommended maintenance and repair projects will produce an annual energy savings of 916 MBTU for a grand total energy savings of 58,057 MBTU.

4.3. ECIP Projects.

PROJECT	COST	ANNUAL SAVINGS		SIR
		MBTU	\$US	
Boiler Plant Modification	275,779	10,426	50,044	2.32
Weatherization	<u>1,386,304</u>	<u>46,715</u>	<u>224,232</u>	2.07
TOTAL	1,662,083	57,141	274,276	

4.4. Projected Utility Costs.

It is not possible to project meaningful future utility cost for the same reasons detailed in 4.1.

4.5. Schedule of Energy Conservation Projects.

PROJECT	COST	ANNUAL SAVINGS		SIR
		MBTU	\$US	
Weatherization	1,386,304	46,715	224,232	2.07
Boiler Plant Modification	<u>275,779</u>	<u>10,426</u>	<u>50,044</u>	2.32
TOTAL	1,662,083	57,141	274,276	

4.5.1. Maintenance and Repair Projects.

PROJECT	COST	ANNUAL SAVINGS		SIR
		MBTU	\$US	
Replace Manual Valves	\$1,176	297	1427	10.6
Window Gasket Maint.	4,122	480	2324	1.94
Weatherstripping	<u>3,258</u>	<u>139</u>	<u>669</u>	1.18
TOTAL	8,556	916	4420	

5. SUMMARY AND CONCLUSIONS

5.1. Summary.

The purpose of this study is to identify and financially evaluate all possible means to reduce energy consumption in compliance with the objectives set forth in the Army Facilities Energy Plan. During the first phase of the study, the 54th Area Support Groups facility at Rheinberg was physically surveyed. This report addresses, possible energy conservation measures that should be implemented, if the facility is purchased. If the 54th ASG acquires this property, they will have 312,000 square feet of administrative space and one million square feet of warehouse/manufacturing space which is planned to be converted to multi-use space. There are insulation deficiencies in both spaces. In all possible considerations of utilization, it would be beneficial to properly weatherize the facility. The existing high pressure boiler plant is grossly oversized for any near term needs of the Army. A secondary boiler plant can be reactivated and distribution systems extended to replace the manufacturing plant's main boilers. There are other miscellaneous minor deficiencies. Projects for weatherization, boiler plant modification and energy monitoring and control systems were evaluated for possible inclusion in the ECIP. The EMCS project failed to qualify because of low savings to cost ratios.

5.2. Conclusions.

The ECIP and Maintenance and Repair projects should be implemented.

Individual mechanical and lighting systems should be designed for each multi-use occupancy. Existing factory ventilation systems would be inappropriate for heating.

The existing high pressure steam distribution system should be deactivated and not used for space heating.

The EMCS project should be re-evaluated after detailed design is completed for the final approved occupancy schedule.